CHIP Results

Coronary Risk Reduction Through Intensive Community-based Lifestyle Intervention: The Complete Health Improvement Program (CHIP) Experience

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SUMMARY

Vigorous cholesterol lowering with diet, drugs, or a combination has been shown to slow, arrest, or even reverse atherosclerosis. Residential lifestyle intervention programs have successfully lowered serum cholesterol levels and other coronary risk factors, but they have the disadvantages of high cost and difficulty with long-term adherence. Community-based risk-reduction programs have the potential to effect change at low cost and improve long-term adherence. To assess the effectiveness of, and to develop a model for, such programs, the community-based Coronary Health Improvement Project (CHIP) was developed in Kalamazoo, Michigan. In the intensive (30-day, 40-hour), hospital-based educational program, participants are encouraged to exercise 30 minutes a day and to embrace a largely unrefined plantfood-centered diet that is high in complex carbohydrates and fiber; very low in fat, animal protein, sugar, and salt, and virtually free of cholesterol. A total of 304 enrollees in the first program were at elevated risk of coronary artery and related diseases: 70% were ≥10% above their ideal weight, 14% had diabetes, 47% had hypertension, and 32% had a history of coronary artery disease. Of the enrollees, 288 "graduated" from the program (123 men, 165 women; mean age was 55 ±11 years). Various markers of disease risk, including serum blood lipids and fasting blood glucose concentrations, were measured before and after the program. At 4 weeks, overall improvements in the participants' laboratory test results, blood pressures, weights, and body mass indexes were highly significant (p <0.001). Triglyeride levels decreased significantly (p <0.05) in participants who had elevated triglyceride levels (>200mg% in men, 200-299 mg% in women).

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"I have always emphasized that bypass surgery is only a palliative treatment. The incidence of coronary disease will only be decreased by proper preventive measures."

—Rene G. Favaloro, MD,
Pioneer of Bypass Surgery

In the United States, as in many industrialized countries, every second man and woman dies of occlusive vascular disease related to atherosclerosis. Starting in childhood and largely asymptomatic, the disease is both insidious and progressive. It expresses itself most frequently as coronary artery disease (with angina and myocardial infarctions as its classical manifestations) and cerebral infarction. Atherosclerosis is also involved in the etiology of dissecting aneurysms, hypertension, congestive heart failure, intermittent claudication, impotence, certain hearing and visual losses, and senility.[1] Atherosclerosis occurs predominantly in patients with hypercholesterolemia, that is total cholesterol levels $\geq$ 180 mg%, or low-density lipoprotein (LDL) cholesterol levels $\geq$100 mg%. Hypercholesterolemia is emerging as the primary, essential, and necessary cause of the epidemic.

Vigorous cholesterol lowering with diet, drugs, or a combination, on the other hand, can lead to anatomic regression of atherosclerotic plaques.[2] It also decreases vascular reactivity, normalizes endothelial reactivity, depletes lipid-rich plaque cores, lowers thombogenicity, decreases inflammatory responses, and enhances coronary blood flow and myocardial perfusion. Several multifactorial, lifestyle risk-reduction trials have clearly demonstrated that atherosclerotic processes can be slowed, arrested, and reversed.[3-5] Clinically, the result is decreased myocardial ischemia, fewer acute coronary events, and fewer revascularization procedures. Substantially lowering serum cholesterol levels should, therefore, be a goal of therapy and a foundation for preventing, treating, and reversing coronary artery disease.[6]

Coronary Risk Reduction Success

Programs that combine lifestyle intervention with medical therapy have been successful. In 1994, the Stanford Coronary Risk Intervention Project (SCRIP)[7] demonstrated the efficacy of comprehensive lifestyle change combined with hypolipidemic medications in slowing the progression of coronary atherosclerosis. One year later, Esselstyn[8] reported his experiment at the Cleveland Clinic with 18 heart disease patients who followed his very-low-fat (10% of total calories), plant-based diet and, where needed, received hypolipidemic medication, bringing their total cholesterol levels <150 mg%. Eleven patients who followed the program had follow-up angiograms, and among these patients at 5 years, I I of 25 lesions had regressed and 14 had been arrested. No patient had any evidence of new infarctions or of clinical progression. In contrast, the patients had experienced 49 cardiovascular events during the 8 years before the study while being treated conventionally at the Cleveland Clinic (when their mean total cholesterol level was 246 mg%).[8]

With lifestyle intervention alone, residential programs, such as the Pritikin Longevity Center' and the McDougall Program,[9] have had considerable success in markedly lowering serum cholesterol levels and other coronary risk factors. Community-based risk reduction trials, however, have had varying degrees of success. The Stanford Five-City Project , with >120,000 people targeted, showed only small reductions in serum cholesterol level (2%), blood pressure (4%), and smoking (13%). This, however, resulted in a decrease in relative risk of total mortality (15%) and coronary artery disease (16%).[10] On the other hand, a 1997 cross-sectional population survey carried out in North Karelia, Finland, showed that the annual coronary artery disease mortality rate in men <65 years of age was 73% lower than the rates in 1972, when Dr. Puska's Comprehensive Cardiovascular Community Control Program (CCCCP) began.[11]

Coronary Health Improvement Project (CHIP) Development

Making community-based health risk reduction successful is one of medicine's most important tasks. As C. Everett Koop, MD, the former US Surgeon General, said, "The greatest challenge in medicine today is to be found in motivating people to assume more responsibility for a health-affirming lifestyle." Responding to that challenge, the Borgess Health Alliance, the Washington, DC- based Center for Science in the Public Interest, the California-based Lifestyle Medicine Institute, and the International Nutrition Research Foundation sponsored the Coronary Health Improvement Project (CHIP) in Kalamazoo, Michigan.

This intensive and comprehensive hospital-based education program is aimed at substantially decreasing the risk of coronary artery disease and its associated diseases—such as type 2 diabetes, essential hypertension, and obesity—through appropriate lifestyle change. The project is intended to test the feasibility of and become a model for cost-effective, community-based coronary health improvement programs.[12]

With a commitment of enrolling a "critical mass" of 3,000 people (i.e., 5% of the adult population in Kalamazoo, Michigan) over 3 years with proper follow-up (alumni activities), CHIP intends to create a health-supportive "subculture" in the community and an interest in lifestyle education among healthcare professionals. The project is designed to assess to what extent a self-selected population, which pays for these services, can contribute to a shift in the lifestyle of the community at large. Although the current focus is on adults ≥40 years of age who are at elevated risk or who already have coronary artery disease, CHIP strongly encourages family members to

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enroll as well because social support can be critical in achieving and adhering to lifestyle change.

In this 4-week, 40-hour intensive educational program, participants meet daily for 2.5 hours from Monday through Thursday. In addition, they attend 2 half day applied nutrition workshops on consecutive Sundays with sit-down banquet meals. For these generally upper-middle- class participants in Kalamazoo, the admission fee is modest (single $250, couples $400), covering the tuition, workbooks, 3 coronary risk-factor screenings (including lipid and glucose assessments), and evaluation sessions.

The primary goals of this comprehensive educational program are to substantially lower blood lipid levels, blood pressures, and blood sugar levels. Secondary goals are to decrease excess weight, eliminate smoking, enhance daily exercise, adopt better stress-coping strategies, and decrease medication for hypertension, diabetes, and heart disease. For each participant, coronary risk-factor levels are carefully assessed before the educational intervention begins, after the 30-day program phase is completed, and then again after 12 months.

TABLE I. CHIP Optimal Diet Composition Versus the Typical US Diet.

	US Diet	CHIP Optimal Diet
Fats and oils	37%*	<15%*
Protein	15%*	10-15%*
Complex carbohydrates	25%*	65-70%*
Simple carbohydrates	23%*	<7%*
Cholesterol	400 mg/day	<50 mg/day
Sugar	35 tsp/day	<10 tsp/day
Salt	12-15 g/day	<5 g/day
Fiber	12g/day	>40 g/day
Water	Minimal	8-10 glasses/day

*Percent of total energy intake

Lifestyle and dietary goals: The exercise and dietary goals participants are encouraged to achieve are walking or exercising 30 minutes a day and embracing the Optimal Diet, which is based on plant foods. This complex-carbohydrate- centered (65-70% of calories) diet emphasizes foods such as grains, legumes, vegetables, and fresh fruits, *ad libitum*. The Optimal Diet is very low in fat, animal protein, sugar, and salt, yet high in fiber and virtually free of cholesterol—a stark contrast to the rich US diet (Table 1).

To help participants maintain their lifestyle changes and to promote community "ownership" of the program, CHIP works closely with its graduates, community organizations, and the media to promote awareness of the program and to educate the public regarding coronary health. CHIP has an alumni association, which holds monthly educational meetings. Moreover, CHIP works closely with existing providers of lifestyle change programs, like smoking cessation and physical fitness programs, to provide follow-up services. CHIP also has sought out close collaboration with local merchants, such as restaurants, supermarkets, and health food stores, to offer meals and foods that are included in the CHIP program diet.

The program also provides exposure, research, and training opportunities

TABLE II. Change, by Gender, in Coronary Disease Risk Factors over 4 Weeks in CHIP Participants.

	Mean (SD) Men (n = 123)	Mean (SD) Women (n = 165)
Age (yr)	54.9 (11)	54.6 (10)
Height (in)	69.7 (3)	63.8 (3)
Weight (lb)		
Before	202.5 (38)	172.1 (43)
After	195.7 (35)	166.9 (41)
Change	-6.8 (5)	-5.2 (4)
Ideal body weight (%)a		
Before	123.9 (19)	128.9 (28)
After	119.8 (17)	125.1 (27)
Change	-4.1 (3)	-3.9 (2)
Body mass indexb		
Before	29.4 (5)	29.8 (7)
After	28.4 (5)	28.9 (7)
Change	-1.0 (1)	-0.9 (0)
Systolic BP (mmHg)c		
Before	132.1 (17)	130.5 (21)
After	127.5 (17)	122.1 (19)
Change	-4.6 (16)	-8.3 (14)
Diastolic BP (mmHg)c		
Before	83.7 (10)	78.7 (10)
After	77.8 (9)	73.2 (9)
Change	-6.0 (8)	-5.5 (9)
Pulse rate (bpm)		
Before	72 (10)	76 (12)
After	65 (8)	70 (11)
Change	-6.7 (9)	-5.2 (8)
Glucose (mg%)c		
Before	111.3 (34)	104.3 (42)
After	99.5 (23)	97.7 (45)
Change	-11.8 (20)	-6.7 (26)
Total cholesterol (mg%)		
Before	222.2 (42)	227.3 (42)
After	180.9 (31)	205.8 (40)
Change	-41.3 (33)	-21.6 (28)
LDL cholesterol (mg%)d		
Before	149.8 (34)	147.2 (38)
After	116.1 (28)	131.1 (34)
Change	-31.9 (26)	-16.3 (26)
HDL cholesterol (mg%)		
Before	35.9 (9)	48.9 (12)
After	32.0 (8)	42.3 (11)
Change	-3.8 (4)	-6.6 (7)
Total/HDL cholesterol		
Before	6.5 (2)	5.0 (2)
After	5.9 (1)	5.2 (2)
Change	-0.6 (1)	*+0.2 (1)
Triglycerides (mg%)e		
Before	190.5 (116)	159.4 (87)
After	163.2 (84)	164.1 (101)
Change	-27.2 (94)	*+4.8 (77)

* p <0.001 for all changes not marked with asterisk.
a 100 x actual weight/ideal body weight (Metropolitan Life Insurance Tables, 1959).
b Weight (kg)/height (m)^2
c The means for blood pressure and glucose in this table are comfounded by medications.
d Some values are missing due to triglyceride levels >400 mg%
e Two male cases were excluded because of extreme values (1,840 and 2.300 mg%). All others <1.000 mg%.
BP = blood pressure. HDL = high-density lipoprotein. LDL = low-density lipoprotein.

for healthcare professionals and university students.

CHIP Program Evaluation

A total of 304 people enrolled in the first CHIP program in Kalamazoo. Of these, 288 (123 men and 165 women) were graduated; they attended at least 80% of the educational lectures. Their mean age was 55 (±11) years; 48% had an income greater than $60,000 per household, and 51 % were at least college graduates. Clinically, 70% of the participants were ≥10% above their ideal weight, 14% had diabetes, 47% had hypertension, and 32% had a history of coronary artery disease. The following evaluation reflects their status before and immediately after completing the 4-week intervention program.

Methods: Each participant gave informed, written consent to the hospital-approved study. Blood samples for measurement of serum lipids and glucose were drawn after a 12-hour fast, just before and at the end of the program. Total cholesterol, high-density lipoprotein (HDL) cholesterol, and triglyceride concentrations were measured.

All blood pressures were taken by trained personnel with the participants seated and rested for at least 5 minutes. Participants' self-reported "miles walked" were collected and recorded daily. Participants filled out questionnaires and were interviewed about their medical history and medication use (participants had to present their medication bottles), diet, levels of stress, and exercise and smoking habits. Based on this information, participants received individualized, written recommendations for lifestyle improvement. All clinical data were analyzed by the Center for Health Research at Loma Linda University's School of Public Health. Data were double-entered, and outliers were identified and excluded from analysis when appropriate. Paired t tests were used to detect any differences in continuous variables. Gender-specific stratified analysis were done. Statistical analysis were performed using SPSS 6.

Results: At 4 weeks, participants had effected significant changes in coronary risk factors. The changes in laboratory results, blood pressure, weight, and body mass index were highly significant (p <0.001) except for the mean total-to-HDL cholesterol ratio and triglyceride levels in women (Table II). Participants walked a total of 11,522 miles during the last 3 weeks of the program, averaging about 2 miles per person per day. Of 9 smokers, 4 quit during the intervention program.

In general, participants who were at greatest risk effected the most change (Table III). For example, although men and women in all total cholesterol categories decreased their levels significantly, those with total cholesterol levels ≥240 mg% achieved much greater reductions than participants with lower levels. Men with high total cholesterol levels effected the most change: those with levels >279 mg% showed a 33% decrease from a mean 305 mg% to 203 mg%. Women in that category brought their total cholesterol levels down 14% from a mean 306 mg% to 261 mg%.

The story of LDL-cholesterol levels was similar, with significant reductions in all categories. The greatest reduction was among men and women with levels >189 mg%. Men in that category achieved a 34% decrease, from a mean 210 mg% to 138 mg%. Women in that category demonstrated a 19% reduction, from a mean 219 mg% to 177 mg%.

The only participants demonstrating significant reductions in total-to-HDL cholesterol ratios were men with ratios >6.0. Among men with ratios of 6.0-7.9, the mean ratio decreased from 7.0 to 6.2. Among those with ratios higher than that, the mean decreased from 8.7 to 7.4.

The complex-carbohydrate-centered diet emphasizing unrefined foods proved very effective in lowering elevated triglyceride

TABLE III. Change in Serum Lipid Levels by Degree of Risk and Gender in CHIP Participants.

	Change (%)	
	Men	Women
Total cholesterol (mg%)		
<200	-11	-7
200-239	-17	-9
240-279	-21	-11
LDL cholesterol (mg%)		
<100	-19	-6
100-129	-15	-6
130-159	-17	-9
160-189	-22	-14
Total/HDL cholesterol		
4.0-5.9	+2*	—**
6.0-7.9	-11	—**
>7.9	-15	—**
Triglycerides (mg%)		
<100	+21	+25
100-199	0*	+9
200-299	-18	-11
300-399	-25	-14*
400-599	-39	-20*

* p<0.05 for all changes not marked with asterisk

**Data are heavily confounded by estrogen use and changes.

TABLE IV. Change in Fasting Glucose Level in Those Not Taking Antidiabetic Agents According to Initial Clinical Diagnostic Category.

		Fasting Glucose (mg%)		
Clinical Category (Fasting Glucose)	n	Mean Before	Mean After	Change (%)
Normal (<101) mg%)	164	91	88	-3
Moderate insulin resistance (101-110 mg%)	59	105	97	-8
Substantial insulin resistance (111-139 mg%)	25	116	98	-18
Full-blown diabetes (≥140 mg% or by history)	19	135	117	-18

p <0.001 for all changes

levels (≥200 mg%). Men with levels of 200-299 mg% showed an 18% decrease, those with levels of 300-399 mg% showed a 25% decrease, and those with levels of 400-599 mg% showed a 39% decrease. A more detailed analysis showed that 34 of 41 men (83%) were able to lower their triglycerides within 4 weeks by an average of 108 mg% without medication. The remaining 7 men had an average increase of 80 mg%. The results for women were similar, although the triglyceride reductions in the women with levels ≥300 mg% did not achieve statistical significance.

The greater the need, the greater the change also held true for weight, with obese participants (≥120 ideal body weight) losing at least 5 lb and morbidly obese (≥150% ideal body weight) men shedding the most, averaging 13.7 lb. Women in these categories lost a mean 6.3 lb and 6.5 lb, respectively.

Elevated fasting glucose levels responded very favorably to this diet and exercise regimen (Table IV). This is particularly rewarding for patients with diabetes. Not shown in Table IV are data on 21 participants taking either oral antidiabetic medication or insulin injections. Each of the 9 insulin-injecting diabetics had to have the insulin dose lowered, some by as much as 30%. Because this dietary regimen, coupled with exercise, is so effective in bringing down exogenous insulin requirements within days, it is imperative that clinicians monitor patients carefully and adjust their medications to prevent insulin shock.

Blood pressures improved similarly, although the changes were confounded by medication changes. Since many patients actually had their antihypertensive medication dose decreased or discontinued, the reductions effected by lifestyle change may actually be more profound. All but 1 of 63 men and women with diastolic blood pressures ≥90 mm Hg were able to decrease their diastolic blood pressures by a mean of I I points. Similarly, 79 of 99 men ‘and women (80%) with systolic blood pressures ≥140 mm Hg decreased their systolic blood pressure by a mean of 20 points.

Changes in resting heart rates demonstrated the effects of exercise. Men and women with the highest pulse rates (>80 beats/min) showed the most change, with a decrease of ≥10 beats/min.

Discussion

Measurable clinical improvements take place in short order in response to substantial lifestyle change. Often, participants were able to decrease or discontinue antidiabetic, hypolipidemic, and antihypertensive medication. Reductions in important markers of coronary risk, such as serum lipid levels, were significant and rapid.

Among serum lipid results, the CHIP triglyceride data deserve special attention. Several studies have reported an increase in triglyceride levels with a very low-fat, high-carbohydrate diet. CHIP data show, however, that triglyceride levels increased almost exclusively in participants whose levels were <200 mg%. The increases were generally mild (Table III), and they are probably of minimal clinical consequence. In contrast, participants with higher levels consistently showed significant decreases in triglyceride levels. These findings confirm other published reports.[8,9,13,14]

The measurable clinical changes in the free-living CHIP participants in response to these lifestyle changes are in the range of results achieved in residential lifestyle centers. But this community-based program is much less costly than a residential one and may be more effective in helping participants maintain their lifestyle changes.

Residential lifestyle programs, such as the Pritikin Longevity Center and the McDougall Program, provide a metabolic ward-like environment where healthier lifestyle patterns can be learned and where clinical benefits can be optimized. Such programs, however' are costly and require many participants to leave their jobs. In contrast, the CHIP program, while facilitating learning with fun and social events, costs little and requires no time off work.

When participants in residential programs go home, they face the same refrigerator, family, friends, cafeterias, and restaurants with minimal psychosocial support. In contrast, with its structured, ongoing alumni chapter, the community-based CHIP program avoids these problems. Participants tend to form lasting social units—they walk together, go on guided shopping tours together, and eat together.

In addition, as the alumni numbers grow, they should achieve a critical mass for developing a healthy subculture in the community. Institutions will likely respond even more to the growing interest in dietary and lifestyle change. The Borgess Medical Center cafeteria, for example, now offers daily CHIP meal options that have become very popular. Some 11 restaurants now offer CHIP-approved meals. Physicians are increasingly referring patients to the CHIP program. Some 8 physicians themselves are now CHIP alumni. CHIP has established itself as a visible and viable player in the community.

The true test, however, will be to what extent people adhere to their new lifestyle and sustain their health benefits. This is currently being assessed.

Acknowledgment

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REFERENCES

1. Diehl HA. Reversing coronary artery disease. In: Temple NJ, DP Burkitt, eds. Western Diseases: Their Dietary Prevention and Reversibility. Totowa, NJ: Humana Press, 1994:237-316.

2. Gould KL, Ornish D, Scherwitz L, Brown S, Edons RP, Hess MJ, Mullani N, Bolomey L, Dobbs F, Armstrong WT, Merritt T, Ports T, Spatter S, Billings J. Changes in myocardial perfusion abnormalities by positron emission tomography after long-term intense risk factor modification. JAMA 1995;254:894-901.

3. Ornish D, Brown SE, Scherwitz LW, Billings JH, Armstrong WT, Ports TA, McLanahan SM, Kirkeeide RL, Brand RJ, Gould KL. Can lifestyle changes reverse coronary heart disease? The lifestyle heart trial. Lancet 1990;336:129133.

4. Schuler G, Hambrecht R, Schlierf G, Niebauer J, Hauer K, Neumann J, Hoberg E, Drinkmann A, Bacher F, Grunze M, Kubler W. Regular physical exercise and low-fat diet: effects on progression of coronary artery disease. Circulation 1992; 96:1-11.

5. Watts GF, Lewis B, Brunt JNH, Lewis ES, Coltart DJ, Smith LDR, Mann A Swan AV. Effects on coronary artery disease of lipid-lowering diet, or diet plus cholestyramine, in the St. Thomas Atherosclerosis Regression Study (STARS). Lancet 1992;339:563-569.

6. Kinlay S, Ganz P. Role of endothelial dysfunction in coronary artery disease and implications for therapy. Am J Cardiol 1997;80(suppl):111-161.

7. Haskell WI, Alderman EL, Fair JM, Maron DJ, Mackey SF, Superko HR, Williams PT, Johnstone IM, Champagne MA, Krauss RM, Farquhar JW. Effects of intensive multiple risk factor reduction on coronary atherosclerosis and clinical cardiac events in men and women with coronary artery disease: the Stanford Coronary Risk Intervention Project (SCRIP). Circulation 1994;89:975-990.

8. Esselstyn CB, Ellis SG, Medendorp SV, Crowe TD. A strategy to arrest and reverse coronary artery disease: a 5-year longitudinal study of a single physician's practice. J Fam Pract 1995;41:560-568.

9. McDougall J, Litzau K, Haver E, Saunders V, Spiller GA. Rapid reduction of serum cholesterol and blood pressure by a twelve-day, very low fat, strictly vegetarian diet. J Am Coll Nutr 1995; 14:491-496.

10. Farquhar JW, Fortmann,SP, Flora JA, Taylor CB, Haskell WL, Williams PT, Maccoby N, Wood PD. Effects of communitywide education on cardiovascular disease risk factors: the Stanford Five-City Project. JAMA 1990;264:359-365.

11. Puska P, Vartiamen E, Tuomilehtc, J, Salomaa V, Nissinen A. Changes in premature deaths in Finland: successful long-term prevention of cardiovascular diseases. WHO Bulletin 1998.

12. Stokols DA. Translating social-ecological theory into the guidelines for community health promotion. Am J Health Promotion 1996;10:282-297.

13. Diehl HA, Mannerberg D. Regression of hypertension, hyperlipidemia, angina and coronary heart disease. In: Trowell HA, Burkitt DP, eds. Western Diseases: Their Emergence, Prevention and Reversibility. London: Edward Arnold, 1981:392-410.

14. Barnard RJ. Effects of lifestyle modification on serum lipids. Arch Intern Med 1991;151:1389-1394.